# Access to Healthy and Less Healthy Food Options In a Low-Income, Racially Diverse Seattle Neighborhood

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## Abstract

Access to Healthy and Less Healthy Food Options
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Seattle Neighborhood

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There is a need for more place-based research on the food environments of low-income and/or racial minority populations for the purpose of developing policy initiatives aimed at decreasing diet-related chronic diseases.

The objective of this study was to describe the availability, price and quality of healthy food options in a low-income racially diverse Seattle neighborhood, to compare the availability of healthy versus less healthy food options and to determine if availability, price and quality of healthy food options are associated with racial composition and median household incomes of the neighborhood.

The research was carried out using an observational measure, the Nutrition Environment Measures Survey in Stores (NEMS-S), in 24 neighborhood food retail stores. Median scores indicate that stores had poor availability of healthy food options, priced them higher than the less healthy alternatives but had quality produce when it was available. Less healthy food options were much more available than healthy food options and no significant difference was seen in availability, price and quality of healthy food options by either neighborhood-level race or income.

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All my love goes to my husband, James Coulter, who has helped me realize my strengths and passions by gently but insistently encouraging me to pursue the public health issues that capture my attention and instill in me a desire to help create change.

## INTRODUCTION

Obesity is a known risk factor for a number of diet-related chronic diseases including cancer, cardiovascular disease, type 2 diabetes and osteoarthritis (1,2). Unfortunately, low-income, rural and/or racial or ethnic minority populations suffer disproportionate rates of obesity and subsequent chronic disease (3,4).

A workgroup from the National Cancer Institute's 2007 "Measures of the Food and Built Environment Workshop" recently called for more research on the food and physical activity environments of these same populations (5). Other research has called for greater specificity in order to nuance place-based policy initiatives aimed at decreasing obesity (6). Describing access to healthy and less healthy food options in a low-income racially diverse Seattle neighborhood provides a baseline assessment of the neighborhood and it is hoped that these measures will stimulate policy changes that may have an effect in reducing obesity and diet-related chronic disease (7).

### Background and Significance

The socioecological framework demonstrates the multiplicity of influences on what people eat (Figure 1).

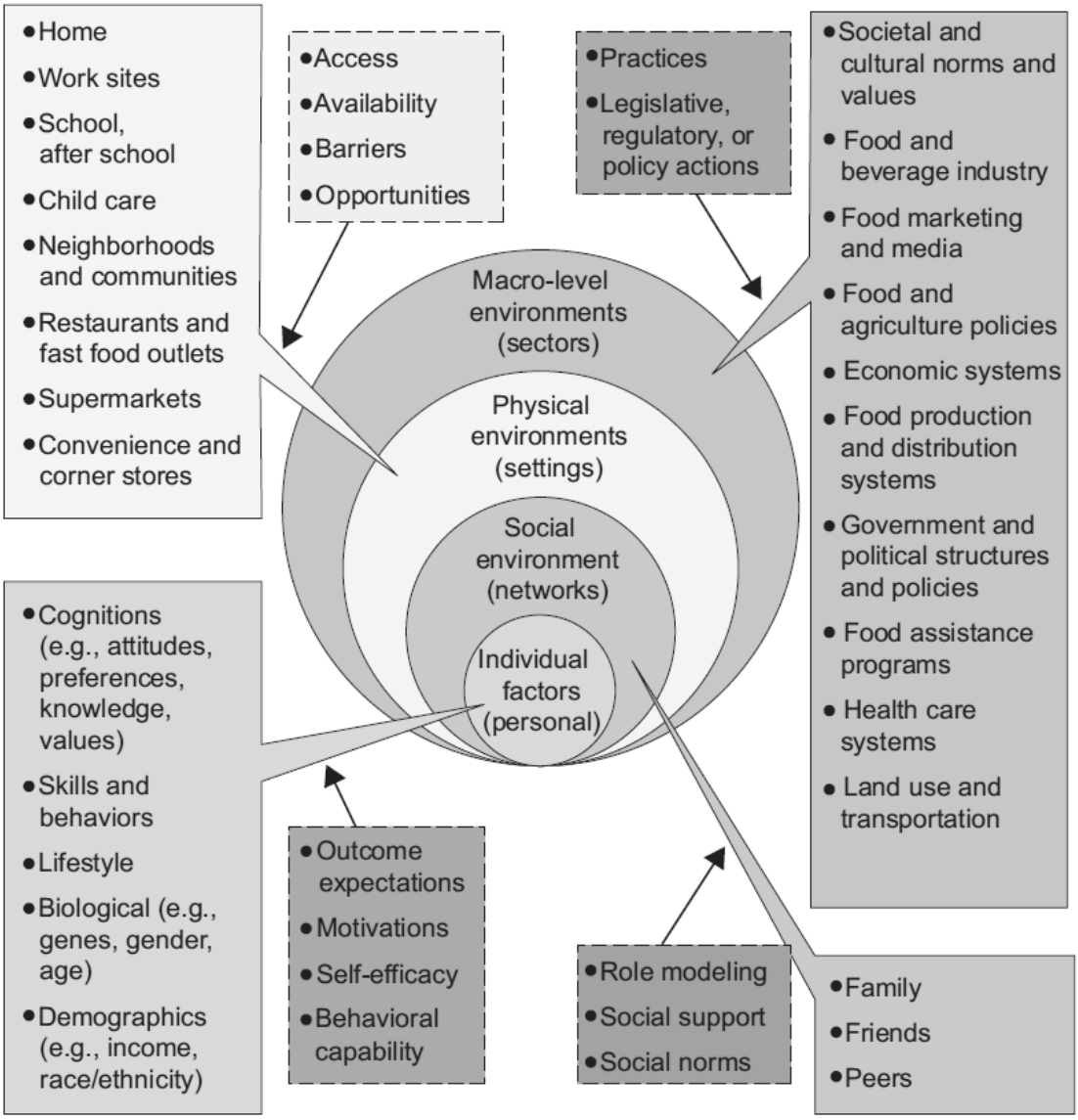


**Figure 1** Socioecological framework demonstrating the multiple influences on what people eat. Adapted from (8).

Early research aimed at reducing obesity rates focused on individual factors, such as behavior modifications, to improve physical activity and diet quality. Unfortunately, attempts to modify individual-level factors have limited effects, which are often not sustained, and tend to impact those already somewhat amenable

to change or already engaging in behaviors closer to the desired behaviors. More recently, research has begun to focus on the influence of the physical environments such as the food/nutrition and physical activity environments. Economic and social factors may limit individual ability to make changes in their food/nutrition and physical activity environments without prior intervention at the community level (9). Therefore, a number of experts and agencies have identified the physical environment and policy interventions as the most promising strategies for creating population-wide improvements in physical activity and diet quality (8,10-12). As shown on Figure 1 physical settings and policy interventions operate at the highest levels of the framework to influence change and likely have more widespread impact on whole populations.

While research in the physical environment has increased, most of the research has focused on the physical activity environment with relatively little focus on the food/nutrition environment (5,11,13). Over the past ten years researchers have been exploring a variety of methods and instruments to measure and assess the influence of the food/nutrition environment on weight status and related behaviors, including examining sources and types of foods available, food price and quality and the availability of nutrition information (4,13).

Glanz and colleagues describe two environments that need to be assessed in order to understand community access to food (13). The first is the community nutrition environment, which includes the number, type, location and accessibility of

food access points such as grocery stores, convenience stores, fast-food restaurants and full-service restaurants (13). The second environment, the consumer nutrition environment, includes what consumers encounter in and around the places where they access food (13).

Previous research has demonstrated that both environments are important in determining the eating patterns of neighborhood residents (14). For example, the presence of nearby supermarkets is associated with a lower prevalence of obesity and overweight (15). For children and adolescents, living in a neighborhood with convenience store density greater than that of grocery stores is significantly associated with a higher probability of being overweight (16,17). People with no supermarkets near their home are more likely to have poor diets than are those with the most nearby supermarkets, and proximity to a supermarket improves the diet quality of pregnant women (18,19).

Community nutrition environment research has also shown disparities in access to healthy foods based on race and income (17,20-24). While it is known that African Americans, low-income and rural populations suffer disproportionate rates of obesity and diet-related chronic disease relative to other racial/ethnic groups and that they are less likely to make food choices consistent with dietary guidelines, surprisingly little research has focused on assessing the food and physical activity environments of these populations (25-28). Yet these populations are more likely to be affected by physical environment factors that make it difficult to access healthy

foods and adequate physical activity (26). For example, a national study found that low-income neighborhoods have three-fourths as many chain supermarkets as middle-income areas, that African American neighborhoods have half as many grocery store chains as white neighborhoods and that Hispanic neighborhoods have only one-third as many (29). Additionally, fast-food restaurants are more prevalent in minority neighborhoods while supermarkets are less prevalent, an issue that some researchers attribute to the exodus of supermarkets from more urban core areas and the influx of fast-food restaurants (11,30). Other research has shown that fruit and vegetable intake is higher with each additional supermarket in a census tract and this elevation was nearly three times as large for African Americans as it was for other racial groups (30,31).

Studies of the consumer nutrition environment have also revealed disparities in food access and associations with intake. One study revealed disparities in access to five foods recommended for diabetics in less-affluent and ethnic minority neighborhoods (32). Cost has been identified to be second to taste among the most important factors for individuals making food choices and other studies have demonstrated that healthier foods cost more (11,33-35). Additionally, minority areas are more likely to be served by independent grocery stores that stock fewer items at higher prices (36,37). Interestingly, government regulations, such as agriculture policy, play a role in the pricing of healthy food versus less healthy food options (11).

High-quality measurement tools are needed to evaluate and describe these different food environments and to identify the variations between and among them. However, as mentioned earlier, the science for measuring food/nutrition environments is not as advanced as it is for physical activity environments (13). One possible explanation for this is that market forces are more prominent in measuring and understanding the food/nutrition environment than they are in the physical activity environment and therefore, that the food/nutrition environment faces more obstacles to change (13). Other explanations include the complexity of the food environment with multi-dimensional issues around the food system including variations in quality resulting from how the food was grown, harvested, processed, packaged and transported to how it was marketed and consumed (13).

The lack of standardized measurements in this field has made it difficult to make comparisons across studies. The issue is currently being addressed by engaging experts in consensus building workshops, such as the National Cancer Institute's 2007 "Measures of the Food and Built Environment Workshop". The Nutrition Environment Measurement Survey in Stores (NEMS-S) is one measurement tool assessing the consumer nutrition environment that has demonstrated excellent reliability and face validity and is gaining momentum as an important food/nutrition environment measurement tool (38,39).

Reliability for the NEMS-S was previously tested in 85 stores in Atlanta, Georgia where both inter-rater reliability and test-retest reliability for all food items

were high, $\kappa$ statistics $\geq$0.83 and $\geq$0.73, respectively (38). The tool has been used in previous studies that have examined the availability and prices of healthful and regular food options across neighborhoods and types of stores and to examine the association of neighborhood racial and income composition with healthy food availability (24,40). A third study used the NEMS-S to study the association between the availability of healthy food and diet quality while a fourth used it to compare proximity to various food outlets in different urban demographic settings (41,42).

The current study aimed to identify neighborhood food stores in a low income racially diverse urban neighborhood and use the NEMS-S to survey and describe the consumer nutrition environment in these stores. The consumer nutrition environment is evaluated in terms of healthy food availability, price, quality and food environment quality. It also makes a comparison of healthy food availability with that of less healthy food options and compares healthy food availability, price, quality and food environment quality by race and household income.

## METHODS

### Neighborhood Selection and Sociodemographic Indicators

The Delridge neighborhood was identified in 2006 by Public Health - Seattle & King County as among those neighborhoods experiencing the greatest disparities in resource access across the county (43). The neighborhood was also selected for participation in the King County Food and Fitness Initiative (KCFFI) funded by the W.K. Kellogg Foundation to begin planning for a ten plus year initiative aimed at **c**reating communities with equitable access to healthy, locally grown food and safe places for physical activity. The initiative, called Food and Fitness, launched nationally in 2007 in nine regions in the U.S. The planning phase for this initiative ended in late 2009 and if the initiative receives further funding, the current research may be used to help guide the second phase of the initiative: implementation.

There is no standard definition of what constitutes an individual's or a neighborhood's food/nutrition environment and therefore no standard boundaries within which such environmental evaluation should take place. This is likely attributable to the relative novelty of measuring and assessing neighborhood environments (4,5). For the purposes of this study the food/nutrition environment was defined using the Health Planning Area (HPA) boundaries defined by Public Health - Seattle & King County. The author recognizes that the area used to define HPA boundaries may differ from that community members use to define their neighborhood (43).

Delridge is a racially diverse area with people of color making up nearly 50% of the community (Table 1), which is significantly higher than the rest of the county. According to the 2000 U.S. Census nearly 30% of Delridge residents speak a language other than English at home. This figure is approximately ten percentage points greater than that of either King County (23.6%) or Seattle (22.5%) (43).

**Table 1** Race (2000 U.S. Census)

| | King County | | Seattle | | Delridge | |
|---|---|---|---|---|---|---|
| **Race** | **Number** | **Percent** | **Number** | **Percent** | **Number** | **Percent** |
| Total | 1,737,034 | 100% | 563,374 | 100% | 31,116 | 100% |
| White alone | 1,315,507 | 76% | 394,889 | 70% | 16,172 | 52% |
| Black or African American alone | 93,875 | 5% | 47,541 | 8% | 3,582 | 12% |
| American Indian and Alaska Native alone | 15,922 | 1% | 5,659 | 1% | 531 | 2% |
| Asian alone | 187,745 | 11% | 73,910 | 13% | 6,577 | 21% |
| Native Hawaiian and Other Pacific Islander alone | 9,013 | 1% | 2,804 | 0% | 372 | 1% |
| Some other race alone | 44,473 | 3% | 13,423 | 2% | 2,087 | 7% |

Mean socio-economic status (SES), described by resident income, educational attainment and employment status is lower in Delridge than in the rest of King County. In 1999, 14% of families in Delridge lived below the poverty level. This is double the rates seen for Seattle (7.1%) and King County (5.6%) (43).

According to the Public Health - Seattle & King County statistics, the Delridge neighborhood is also experiencing higher rates of obesity and diet-related

chronic diseases as compared to the county overall. Using a five year average between the years of 2004-2008, 22.9% of Delridge residents were obese compared to 19.8% of the county population. Delridge experiences a rate of 171.5 cardiovascular disease deaths per 100,000 residents compared to the county rate of 145.9 and 29.2 diabetic deaths per 100,000 residents compared to the county rate of 20.1 (44).

**Identification of Stores**

Retail food stores were identified using Google Maps and by fieldwork. To identify stores using Google Maps the following search terms were used: convenience store, mini-mart, market, food store, retail food store, food mart, corner store, mom and pop store, bodega and grocery store. Fieldwork was conducted to verify the locations of the stores and additional stores noted during this fieldwork were added as they were identified. For the purposes of conducting the NEMS-S the stores were classified into two main categories: grocery stores and convenience stores. Stores that fell outside of the study boundary or were closed to the public were excluded.

**Outcome Assessment**

The NEMS-S tool was used to measure the food environment in terms of availability, price and quality. NEMS-S measures the availability and price of 11 indicator food categories based on their contribution of fat and calories to the American diet and those alternative items most recommended for healthy eating.

NEMS-S defines healthy food options based on publications of federal agencies, health professional organizations and researchers (38). The indicator categories are identified in Table 2 below.

**Table 2** NEMS-S Variables Assessed by Direct Observation. Adapted from (38).

| | Variables Measured | | | |
|---|---|---|---|---|
| | Availability | Price | | Quality |
| Type of Food | | Absolute | Comparative | |
| Milk: skim/low-fat versus whole | X | | X | |
| Fruit (fresh): 10 types | X | X | | X |
| Vegetables (fresh): 10 types | X | X | | X |
| Ground beef: lean versus regular | X | | X | |
| Hot dogs: low-fat versus regular | X | | X | |
| Frozen dinners: reduced calorie versus regular | X | | X | |
| Beverages | | | | |
| Soda: diet/low-calorie versus regular | X | | X | |
| Fruit juice: 100% juice versus regular juice drinks | X | | X | |
| Baked goods: lower fat versus regular | X | | X | |
| Bread: 100% whole grain versus refined | X | | X | |
| Snack chips: baked/low-fat versus regular | X | | X | |
| Cereal: low-sugar versus regular | X | | X | |

Measurement criteria are based on federal government and industry standards/definitions (e.g. lean beef as 90% lean/10% fat, low-fat products, standard

package sizes etc.) (38). Produce measures are based on the federal and industry data identifying the top ten most consumed fruits and vegetables in the United States (38). Potatoes were excluded from this list to be consistent with dietary assessment approaches used in nutrition epidemiology research. Price was assessed based on the nonsale listing and quality measures of available fruits and vegetables were determined by the majority of the produce being acceptable/unacceptable (38).

Verbal consent for store participation in the survey was obtained from an employee or from the store owner at the employee's discretion before surveying began. All ratings were completed between 9 a.m. and 4 p.m. to ensure consistency of shelf stocking. The University of Washington's Human Subjects Division granted the study a Certificate of Exemption on 7/30/2009 determining that the study does not meet the federal definition of "human subjects research" and therefore does not require review by the Internal Review Board.

**Data Analysis Methods**

NEMS-S data were recorded by hand at each food store and subsequently analyzed using Stata 10 (StataCorp. 2007. *Stata Statistical Software: Release 10*. College Station, TX: StataCorp LP). Data entry was verified by double entry.

Availability scores were assigned by indicator food categories. Each non-produce category scored two points for availability of the healthier option and five indicator categories received an extra one to two points for having more varieties available. The fresh fruit and vegetable categories scored one point for having 1-5

varieties available and an extra one to two points for more varieties available. A score of zero indicates a lack of availability for any healthy foods while the maximum score, 30, indicates that all healthy foods were available.

Price scores indicate the difference between the prices of healthy options and that of less healthy options. The fresh fruit and vegetable categories do not have less healthy alternatives and were therefore excluded from scoring according to price comparisons. For the remaining categories, price scores were assigned with two points for a lower priced healthier option and -1 point for a higher priced healthier option. Pricing the healthier option the same as the less healthy option earned one point in the milk category while all other categories received zero points for equal pricing. A score of -9 indicates that all healthy non-produce indicator foods were priced higher than their less healthy counterparts while a maximum score of 18 indicates that all healthy non-produce indicator foods were priced lower than their less healthy counterparts.

Only the fresh fruit and vegetable categories were evaluated for quality. One point was awarded for 25-49% of available produce being of acceptable quality, two points for 50-74% and three points for 75%+ being of acceptable quality. Therefore a quality score of zero indicates that less than 25% of produce was of acceptable quality, while a maximum of six points was awarded for having 75%+ of available produce being of acceptable quality.

According to NEMS-S scoring, a composite "food environment quality" score was calculated for each store using the variables of availability, price and quality (38). The minimum composite food environment quality score of -9 indicates that no healthy foods were available, that all healthy non-produce foods were priced higher than their less healthy counterparts and that no produce was of acceptable quality. The maximum composite food environment quality score of 54 indicates that all healthy foods were available, that all healthy non-produce foods were priced lower than their less healthy counterparts and that all produce was of acceptable quality.

Availability of healthy food options was compared to that of less healthy food options by total counts of indicator foods available. Maximum score for healthy food items was 30 (9 indicator foods with 100% juice and diet soda counted separately, 10 fruits and 10 vegetables) while maximum count for less healthy food options was 10 (9 indicator foods with juice drink and regular soda counted separately). The availability scores are described using percent ratios of availability for healthy and less healthy food options. The closer the value is to one the greater the availability. Finally, a comparison of healthy food options to that of less healthy food options was made. This was done by dividing the percent ratio of healthy food availability into that of less healthy food availability. The closer the value is to one the more equal the availability of healthy and less healthy food options.

Data from the 2000 Census were used to identify census blocks that have one or more food stores as well as to specify the census block's race make-up and median household income. Fourteen of the 27 census blocks contained within the HPA contained at least one food store. For the store-level analysis stores were analyzed independently of one another, even when more than one store was located within a census block. For the census block-level analysis, the store within a census block with the highest price, availability, quality and food environment quality score was used as an indicator of the retail nutrition environment for that census block.

Race was classified by majority (>50%) non-Hispanic white or non-white and median household income was categorized into tertiles. Low availability, price, quality and food environment quality scores were defined as those scores falling below the median for this sample of stores, while high price, quality and food environment quality scores were defined as those scores above the median. Differences between low and high determinations among census blocks by race and median household income were analyzed using chi-square test, and due to small sample size, Fisher's exact test.

# RESULTS

## Description of Sample and Response Rates

A total of 23 stores were identified using Google Maps (1 grocery store and 22 convenience stores). Fieldwork eliminated two convenience stores as their locations could not be verified. During fieldwork an additional four convenience stores were located for a total of 25 stores. One convenience store declined participation for a 95.8% completion rate. Twenty-four stores are included in the final analysis. The mean time to complete the NEMS-S was 28.2 minutes.

## Availability, Price, Quality and Food Environment Quality of Healthy Food Options

The availability, price, quality and food environment quality of healthy food options are described in Table 3. Quality scores are not normally distributed; median is used as a measure of central tendency.

**Table 3** Store Availability, Price, Quality and Food Environment Quality of Healthy Food Options (n=24)

| | Median | 25th percentile | 75th percentile | Range |
|---|---|---|---|---|
| **Availability** | 9 | 6 | 11.5 | 1 to 28 |
| **Price** | 0 | -0.5 | 1.5 | -2 to 9 |
| **Quality†** | 4 | 3 | 6 | 2 to 6 |
| **Food environment quality** | 11 | 7.5 | 15 | 0 to 43 |

† Only stores that carried fresh produce are included in the analysis (n=12)

Availability had a possible point range of 0 to 30 while the actual range was 1 to 28 (see Table 3). The median and interquartile range (IQR), describing the bounds of the data at the 25th and 75th percentile, indicate that despite the large range in availability, a greater number of stores scored at the lower end of that range. Figure 2 shows the score distribution by number of stores. The lone grocery store earned the highest availability score of 28.

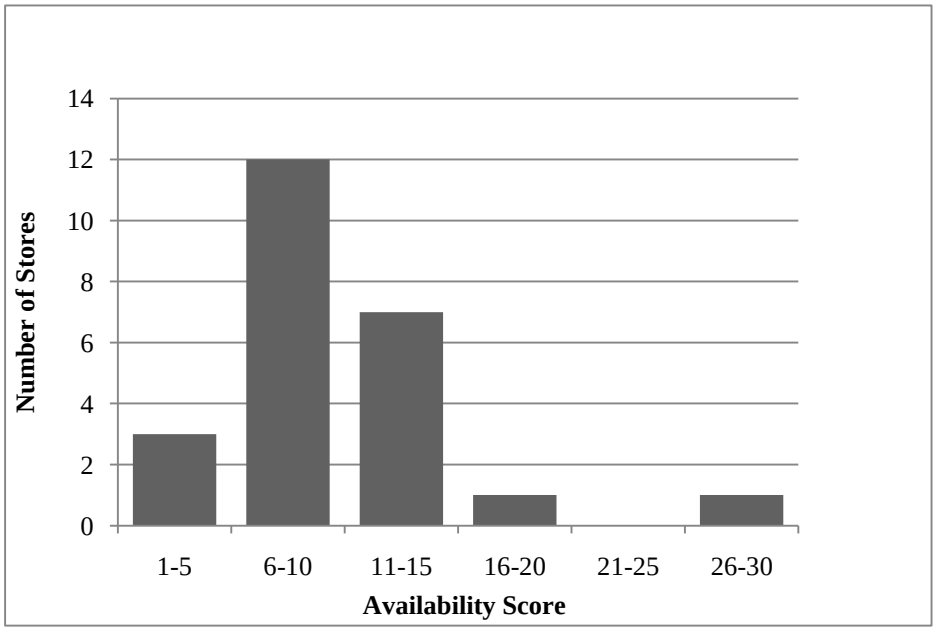


**Figure 2** Availability Score Distribution Among Stores (n=24)

Twelve stores had fresh produce available. Of those stores, five carried fresh fruit (all five stores carried less than five varieties of fruit), one store carried only fresh vegetables (again, less than five varieties of vegetables) and six stores carried both fresh fruit and fresh vegetables (three stores carried less than five varieties of each and the remaining three stores carried between 5-9 varieties of each). Bananas

were available in ten of the stores surveyed while apples, oranges and tomatoes were the next most commonly available produce items being carried in seven stores each.

Price, with a possible point range of -9 to 18, ranged from -2 to 9. Figure 3 shows the score distribution by number of stores. The median (see Table 3) demonstrates that some stores are pricing healthy foods above that of the less healthy alternative and that no store is consistently pricing healthy foods lower than the less healthy alternative. Of the healthy foods, low-fat milk, 100% juice and baked chips were more likely to be priced higher than their alternates while healthy cereal was the most likely healthy food to be priced lower than its less healthy alternate.

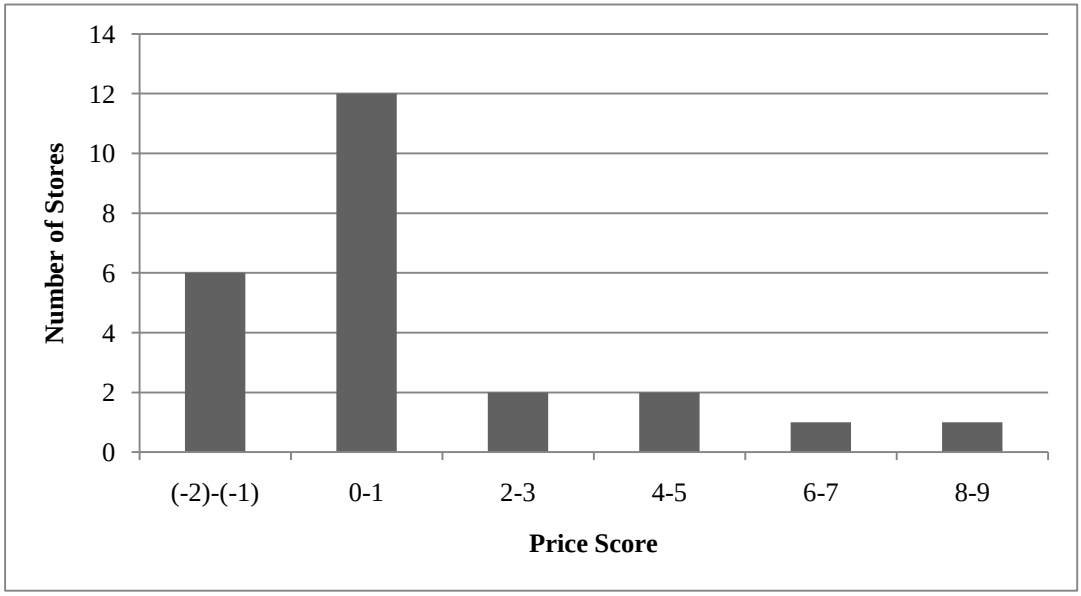


**Figure 3** Price Score Distribution Among Stores (n=24)

Only stores that carried either fresh fruit or vegetables were included in the quality analysis (n=12). The stores analyzed had a possible quality range of 0 to 6

points and actually ranged from 2 to 6. Figure 4 shows the score distribution by number of stores. The median and IQR (see Table 3) demonstrate that quality produce ranged from 37-100% and that on average, about 62% of the fresh produce was found to be of acceptable quality. Here, the grocery store and four convenience stores carried produce in the 75%+ quality range.

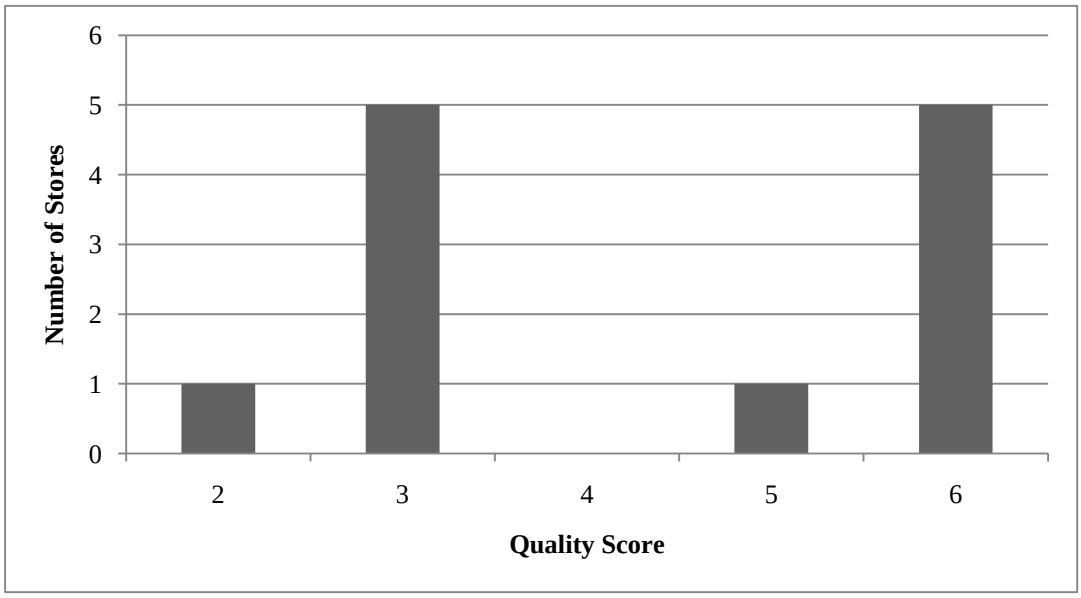


**Figure 4** Quality Score Distribution Among Stores (n=24)

Food environment quality had a possible range of -9 to 54 points. The actual range was from 0-43. The median and IQR (see Table 3) indicate that despite the large range in food environment quality, a greater number of stores scored at the lower end of that range. Figure 5 shows the score distribution by number of stores. Here again, the grocery store earned the highest score.

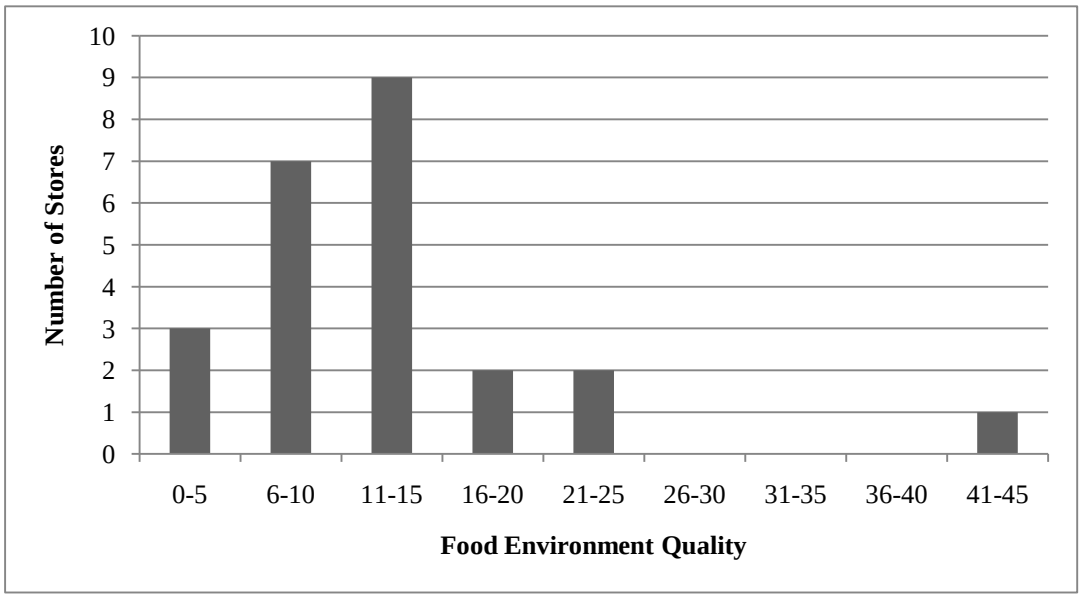


**Figure 5** Food Environment Quality Score Distribution Among Stores (n=24)

**Availability of Healthy Food Options versus Less Healthy Food Options**

The availability of healthy food options versus less healthy food options is described in Table 4. The median demonstrates that, on average stores had 20% of the healthy foods available and 85% of the less healthy alternatives available. The ratio of healthy food options to less healthy food options reinforces the fact that healthy food options were much less available than the less healthy food options.

**Table 4** Neighborhood Availability of Healthy and Less Healthy Food Options† (n=24)

| | Median | 25th percentile | 75th percentile | Range |
|---|---|---|---|---|
| **Healthy** | 0.2 | 0.15 | 0.28 | 0.03 to 1 |
| **Less healthy** | 0.85 | 0.55 | 0.9 | 0.1 to 1 |
| **Healthy: Less healthy** | 0.28 | 0.22 | 0.37 | 0.08 to 1 |

† Expressed as a percent of the total number of foods surveyed

**Demographic Characteristics and Availability, Price, Quality and Food Environment Quality of Healthy Food Options**

Table 5 shows the distribution of stores by type according to race and median household income. Stores were found in fourteen census blocks and were distributed as follows: ten census blocks contained one store, one census block contained two stores, two census blocks contained three stores and one census block contained six stores (including the lone grocery store). All of the census blocks containing more than one store were classified as non-white and had median household income ranges that fell into the low to medium tertiles.

**Table 5** Number of Stores by Type According to Race and Median Household Income (n=24)

| **Type of Store** | **Census Block Race** | | **Census Block Median Household Income Tertiles** | | |
|---|---|---|---|---|---|
| | > 50% non-white | > 50% non-Hispanic white | Low ($12,600-33,182) | Medium ($33,182-42,200) | High ($42,200-60,000) |
| **Convenience** | 16 | 7 | 7 | 8 | 8 |
| **Grocery** | 1 | 0 | 1 | 0 | 0 |

Tables 6 and 7 show the distribution of availability, price, quality and food environment quality of healthy food options by race and income of the census block where the store was located. None of these store-level variables were found to be associated with census block race. Of all of the variables, availability differed the most with 64.7% of non-white census blocks surveyed being located in areas with low healthy food availability compared to only 28.5% of the non-Hispanic white census blocks.

**Table 6** Store-level Census Block Race and Availability, Price, Quality and Food Environment Quality of Healthy Food Options (n=24)

| Race | Availability | | Price | | Quality | | Food environment quality | |
|---|---|---|---|---|---|---|---|---|
| | Low (n=13) | High (n=11) | Low (n=14) | High (n=10) | Low (n=12) | High (n=12) | Low (n=13) | High (n=11) |
| **Non-Hispanic white** | 2 | 5 | 5 | 2 | 3 | 4 | 3 | 4 |
| **Non-white** | 11 | 6 | 9 | 8 | 9 | 8 | 10 | 7 |

Likewise, none of the store-level variables were associated with census block median household income (Table 7). Price showed the greatest difference with 75% of medium income census blocks being located in areas where healthy foods are priced higher than their less healthy alternatives as compared to 50% of both the low and high income tertiles. However, none of the results were found to be significant.

**Table 7** Store-level Census Block Median Household Income and Availability, Price, Quality and Food Environment Quality of Healthy Food Options (n=24)

| Tertiles of median household income | Availability | | Price | | Quality | | Food environment quality | |
|---|---|---|---|---|---|---|---|---|
| | Low (n=13) | High (n=11) | Low (n=14) | High (n=10) | Low (n=12) | High (n=12) | Low (n=13) | High (n=11) |
| **Low** | 4 | 4 | 4 | 4 | 5 | 3 | 5 | 3 |
| **Medium** | 5 | 3 | 6 | 2 | 3 | 5 | 4 | 4 |
| **High** | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |

Similar results were obtained for associations with the census block-level analysis between median household income and race and availability, price, quality and food environment quality. Tables 8 and 9 present the results for this census block-level analysis in each of the 14 census blocks. None of these associations were statistically significant.

**Table 8** Census Block-level Race and Availability, Price, Quality and Food Environment Quality of Healthy Food Options (n=14)

| **Race** | **Availability** | | **Price** | | **Quality** | | **Food environment quality** | |
|---|---|---|---|---|---|---|---|---|
| | Low (n=6) | High (n=8) | Low (n=8) | High (n=6) | Low (n=10) | High (n=4) | Low (n=6) | High (n=8) |
| **Non-Hispanic white** | 2 | 5 | 5 | 2 | 5 | 2 | 3 | 4 |
| **Non-white** | 4 | 3 | 3 | 4 | 5 | 2 | 3 | 4 |

**Table 9** Census Block-level Median Household Income and Availability, Price, Quality and Food Environment Quality of Healthy Food Options (n=14)

| **Tertiles of median household income** | **Availability** | | **Price** | | **Quality** | | **Food environment quality** | |
|---|---|---|---|---|---|---|---|---|
| | Low (n=6) | High (n=8) | Low (n=8) | High (n=6) | Low (n=10) | High (n=4) | Low (n=7) | High (n=7) |
| **Low** | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 1 |
| **Medium** | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 2 |
| **High** | 4 | 4 | 4 | 4 | 7 | 1 | 4 | 4 |

## DISCUSSION

By directly measuring the availability, price, quality and food environment quality of healthy and less healthy food options it is possible to describe the neighborhood food store environment and analyze associations between those variables and race and household income. In describing this neighborhood's food environment, the current study found that healthy foods are mostly unavailable (with a median of 9 of 30 healthy food items surveyed for actually available) and that these available healthy food items (particularly low-fat milk, 100% juice and baked chips) are often priced higher than their less healthy alternatives. Healthy food items were, on average, four times less likely to be found in the neighborhood than their less healthy food alternatives. It was also found when fresh produce is available, that a majority of it is quality produce. Overall, however, the stores had a low median (11 out of 54) score of composite food environment quality.

The results also indicate that within the study neighborhood there is no differential access to healthy foods by neighborhood-level race or median household income. That said, the results do demonstrate that across the neighborhood there is poor availability of healthy foods and when they are available, they are priced higher than their less healthy alternatives. Furthermore, while the majority of available produce was found to be quality produce it was also poorly available. Only twelve of the 24 stores surveyed carried any fresh produce and nine of these stores carried less than five varieties. All of these variables make significant contributions to the neighborhood's overall low food environment quality. Based on these results, it is at

least theoretically possible that the low food environment quality is contributing to the neighborhood's high rates of obesity and diet-related chronic diseases.

The study findings on poor availability of healthy foods and their higher price compared to less healthy alternatives are similar to previous research (33,45,46). Farley et al. conducted measurements of shelf-space for produce and snack foods in 419 stores in 217 urban census tracts in southern Louisiana and in Los Angeles County. They found that grocery stores dedicated more shelf-space to unhealthy snacks than to all produce combined. They also found that convenience stores had a slightly better ratio of the total shelf-space for produce to the total shelf-space for unhealthy snack items (45). Using a similar method, Rose et al. measured the linear shelf-space of fruits, vegetables, and energy-dense snack foods in 307 food stores found in 103 randomly sampled urban census tracts in southeastern Louisiana. They found that households had 18 meters of fruit and 34 meters of vegetable shelf-space within 1 kilometer of their residences. However, the amount of candy shelf-space alone, within the same distance, was more than twice that of vegetables and four times that of fruits (46).

Jetter and Cassady compared the cost and availability of a standard market basket of foods with that of a healthier basket in 25 stores in Los Angeles and Sacramento (33). They found that neighborhoods served by smaller grocery stores had limited access to healthy alternatives and that the healthier two-week market-basket was more expensive (33).

Similarly, previous research has also found that when fresh produce is available in a neighborhood, it is generally quality produce. Cummins et al. conducted a cross-sectional quality survey of twelve fresh fruit and vegetable items in 288 food stores in ten Scotland communities varying from urban to rural settings. They found that the quality of fruit and vegetables within the surveyed stores was high but did vary slightly among types of stores (47). Other research has looked at the role of perceived quality of available produce and intake among African-American women living in a Detroit neighborhood that is not served by a grocery store (48). In this study, positive perceptions of produce quality was positively associated with increased intake, independent of store type and location, resident age, per capita income, and years of education (48).

Analysis of the current study data also found that there was no significant difference between healthy food availability, price, quality and food environment quality and either neighborhood-level race classification (predominantly non-Hispanic white or non-white) or household income. These results are most similar to work by Smith et al. who found that associations between neighborhood deprivation and grocery store accessibility vary by environmental setting (49).

The current study findings are in contrast to a number of research studies that have found significant differences by neighborhood-level race classification or household income (20,22-24). Franco et al. conducted a cross-sectional study in 226 food stores within 159 census tracts in Baltimore City and Baltimore County. They

created a healthy food availability index (HFAI) for each store and described neighborhood healthy food availability using the mean HFAI for all of the stores within that neighborhood (24). They found that 43% of predominantly black neighborhoods and 46% of lower-income neighborhoods were in the lowest tertile of healthy food availability as compared to 4% and 13% of predominantly white and higher-income neighborhoods (24). Zenk et al. looked at availability, price and quality of food in four Detroit communities using a cross-sectional observational design. They surveyed for 80 fruits and vegetables, evaluated quality according to USDA guidelines for a subset of 20 produce items, and assessed price for 20 produce items using the lowest-cost method (20). Their findings show that mean quality of fresh produce was significantly lower in the African-American community with low-socioeconomic position than it was in a more racially heterogeneous, middle-socioeconomic position community. Store type only partially explained the quality differential (20).

Galvez et al. completed a cross-sectional survey of 165 census blocks in East Harlem. The blocks were classified as either 75% African American or 75% Latino and compared available food store types with that of racially mixed census blocks (23). They found that no census block classified as African American contained either a supermarket or a grocery store and that these census blocks were less likely to have convenience stores than were racially mixed census blocks (23). In contrast, census blocks classified as 75% Latino were more likely to have convenience stores, full-service restaurants and fast-food restaurants than racially mixed census blocks

(23). Similarly, Morland and Filomena conducted a cross-sectional study to evaluate the availability and variety of produce in two racially and economically diverse urban neighborhoods. They randomly sampled and surveyed for 20 types of fresh fruits and 19 types of fresh vegetables, as well as their varieties and whether they were canned, frozen or previously prepared for half of the food stores in specific neighborhoods of Brooklyn, New York (22). They found that a supermarket was located in approximately every third census tract in predominantly white areas and every fourth census tract in racially mixed areas. Again, there were no supermarkets located in the predominantly black areas. They also found that a lower proportion of predominantly black area stores carried fresh produce than did white area stores (22).

Reasons for the discrepancies in the current study findings and that of previous studies may be due to the small sample size of the current study which lead to the generic race classifications of non-Hispanic white and non-white, the limited income variability of the neighborhood and the plausible explanation that healthy food availability, price, quality and food environment quality does not differ by neighborhood-level race classification or household income and that a new model for such research is needed. It should also be noted that several of the previous studies used commercially available lists to identify neighborhood food stores. At least one of the studies did not conduct fieldwork to verify the accuracy of the list provided (22).

Strengths of the study include the direct measurement of healthy food availability and the evaluation of food availability in a specific location. Previous research has used the type of food store in a neighborhood as a proxy measure for food availability rather than survey actual food availability (30,48). Other research has shown that healthy food availability may differ substantially across the same types of stores located within a neighborhood (24). This direct measurement of healthy foods also provides the baseline assessment of the consumer nutrition environment (i.e. the environment that consumers confront when making food choices). Such an assessment of the consumer food environment may stimulate changes that neighborhood merchants are be able to make on their own with or without encouragement from public health professionals and governmental policy changes (50).

Limitations of the current study include use of HPA to define the study neighborhood. Such a definition may differ from how members of the community define their neighborhood and assumes that people living in the neighborhood shop in the neighborhood, prefer not to travel far for their food shopping, that they are aware of the stores in their neighborhood, prefer them and are motivated to shop there (10). Further limitations of the study include the limited scope (Delridge is just one low-income Seattle neighborhood) and that the NEMS-S was conducted one time during one season. Similar to other cross-sectional observation studies, the current study does not capture the fluctuating availability and cost associated with seasonality (38,51). And there are limitations to the use of the NEMS-S tool

including the lack of a standardized definition of the relevant food shopping neighborhood, the lack of measures to assess accessibility of the store and its interrelationship with the physical environment and finally, the large investment of personnel time to travel to and assess each food store. Improvements to the NEMS-S can be made by tailoring the tool to survey for healthy and less healthy food alternatives that are most relevant to the study population.

For the most part, neighborhood environmental research operates under the model of deprivation amplification. This model outlines the belief that poorer and minority neighborhoods tend to have fewer health-promoting resources compared to their wealthier and whiter counterparts. Some researchers feel that the model is misguided and that research may need to shift away from this model toward one that takes into account the social processes and symbolic relationships between individuals and their environments (49,52). Cummins suggests that research using the deprivation amplification model is limited by confounding. Individuals are not randomly assigned to neighborhoods. People choose to "locate in neighborhoods based on their incomes, lifestyles, preferences, proximity to work and a variety of other factors" (10). Confounding is then present because the individual has selected the neighborhood based on his/her personal factors and those of the neighborhood. As stated by Lytle, eventually both "parties" affect each other (10).

Further research is needed to better understand the food purchasing behaviors of individuals (i.e. Do individuals shop in their home neighborhood or that of

employment or where their children attend school? How far are they willing to travel to get the food they want? How many stores do they shop at and what kinds of stores are they?). Many previous studies have been conducted in geographic areas with just one or two racial/ethnic groups; this study opens up the need for ongoing research to more fully understand food shopping behaviors in the complex context of acculturation and language in highly diverse immigrant populations.

Additional research is also needed to understand the decisions made by small food retail owners. What incentives are provided by wholesale suppliers? What are the costs to small business owners, and where are the opportunities for profit? What are the business models for neighborhood stores in relation to larger full service grocery stores? What opportunities are there for incentivizing both local stores and food companies to market healthier food options?

Ultimately, it is hoped that these questions, along with baseline assessments of the consumer nutrition environment, will provide the basis for developing programs and policies for change that may have population benefits in reducing obesity and diet-related chronic diseases. In order to do so, neighborhood environmental research needs to further explore the relevance of the research model largely in use and perhaps shift or certainly nuance the model and its tools to better reflect the complex relationships between food environments and populations.

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